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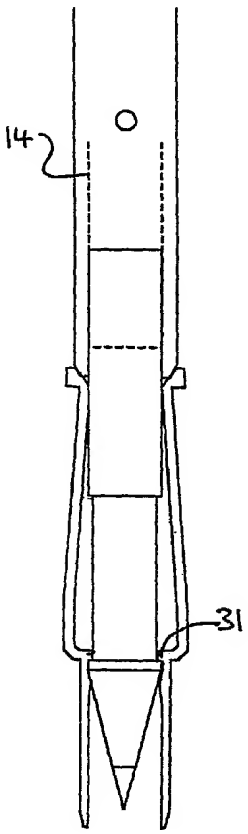
(54) Title: A SHIELD TEST TOOL FOR A BOND TESTER

(57) Abstract: A mechanical test device for electrical bonds includes a holder having a tubular housing (11) and a projecting test tool (20) in the holder. The test tool (20) has a shield (26) slidable axially from a withdrawn condition, to an extended condition in which the tip of the tool (20) is shielded. Gripping means (28,37) hold the shield (26) in the extended condition.



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A SHIELDED TEST TOOL FOR A BOND TESTER

This invention relates to bond testers which are machines for testing the electrical bonds in e.g. semi-conductor devices such as cell phones.

An electrical bond in a semi-conductor device is often almost invisible to the naked eye. For example a wire bond typically comprises a bare wire of about 0.025mm in diameter connected to respective bond sites of the semi-conductor device. Such wire bonds are tested by hooking the wire with a test tool, and applying a tensile forced to establish the yield load. It will be appreciated that there are significant difficulties both in locating the test tool, and measuring the very low yield loads recorded. In practice binocular magnification is used by the operator to guide the test tool, and special low friction techniques have been developed so that yield load is not masked by the inherent frictional forces within the test mechanism. Conventional bearings are not suitable.

Another kind of bond site comprises a solder ball of 0.1mm or less in diameter, which is subjected to a shear test by applying a test tool to the side and applying a compressive force until the ball is sheared, or the bond between the ball and the substrate is broken. Again considerable precision is required, particularly to avoid the test tool dragging on the substrate as the shear load is applied.

A typical test machine is adapted to take several alternative load cartridges, one for each type of test, and each load cartridge may be adapted to receive several alternative test tools, depending on the precise nature of the bond to be tested.

One problem with such machines is that the test tip of such alternative tools, being somewhat delicate, loses concentricity or is easily damaged whilst being substituted. Such tools are also subject to the risk of damage whilst out of use, and even if provided with a protective case they may be damaged whilst being put in or taken out of the case. Furthermore, dust or skin may adhere to the tip, preventing correct operation thereof, or obscuring the orientation during positioning.

According to a first aspect of the invention there is provided a test device for mechanical testing of electrical bonds, the device having a body adapted to be secured in a holder, an elongate tubular housing extending from the body, and a test tool being located in said housing and projecting therefrom, wherein a tubular sleeve is provided

around said tool, and is slidable axially thereof from an extended position in which the tip of the test tool is shielded, to a withdrawn position in which the tip of the test tool is exposed, the sleeve further including gripping means to maintain the sleeve in the extended position.

The means for maintaining the sleeve in the extended position preferably comprise a resilient 'O' ring fixed relative to one of the tip and shield and slidable on the other of the tip and shield against the inherent gripping force. In the preferred embodiment the 'O' ring is housed in an internal annular recess of the shield. Such an arrangement is capable of retaining the shield in the extended and withdrawn positions.

Such an arrangement provides the test tool with an integral protective jacket which can be grasped and advanced over the tip to prevent damage thereto.

In addition, or in the alternative, the shield may include releasable locking means to maintain the shield in the extended position.

In a preferred embodiment, the sleeve provides a grasping means whereby the test tool is inserted and removed from the housing. Preferably the sleeve also constitutes releasable retention means for the test tool.

In a preferred embodiment the sleeve and test tool have stroke limiting means to determine relative axial end positions. In one embodiment the sleeve has a distal end comprising a cylinder and a proximal end comprising a plurality of circumferentially spaced and inwardly directed spring arms having latch projections thereon for engagement in one or more corresponding latch recesses of the housing. The sleeve may further include a bayonet connection with the housing whereby the sleeve is maintained in a desired angular position, the latch projections engaging the latch recesses only on full engagement of the bayonet.

Preferably the housing includes an internal abutment for the test tool whereby, in the latched condition, the tool and abutment are in direct contact.

In the preferred embodiment the test tool further includes means to prevent relative rotation thereof relative to the housing. Such means may comprise a flat of the tool shank engageable with a corresponding internal surface of the housing. The shank and/or housing may include a tapered head to facilitate engagement thereof.

In another aspect, the invention comprises in combination a test tool and sleeve, as mentioned above, and adapted for fitting to a bond testing device.

The test head of a pull testing device includes a co-axial drive motor to permit rotation of the test probe, for example to rotate a hook tool through 90° for engagement under a wire bond. In certain circumstances it has been found that the test head is susceptible to resonant vibration, which can be improved by removing mass. However removal of sufficient mass is somewhat problematic because the overall mass is already low.

According to another aspect of the invention there is provided a bond testing device comprising a test head mounted on a base plate by a cantilever arm extending on a first axis, the test head having a test tool axis at right angles to said first axis, and the device further including a motor rotatable about said tool axis, wherein said motor is mounted on said baseplate for movement along the test tool axis and for engagement and disengagement with said test head.

Such an arrangement permits the motor to be coupled to the test head for rotational positioning thereof, and de-coupled during a test procedure.

The motor may for example be mounted on a resilient cantilever arm, and moved by an air actuated ram. On release of the ram, the inherent resilience of the arm returns the motor to the rest condition, preferably the coupled condition.

An automatic coupler may be provided on the motor for example a fork for engagement with a cross pin of a rotatable shaft of the test head.

The decoupled motor allows the mass of the test head to be significantly reduced, thereby permitting a resonant vibration threshold of over 20 Hz.

US Patent 6,078,387 (Dage) discloses an air bearing/clamp arrangement for a bond tester, which is adapted to eliminate friction during positioning of a shear test probe. The test head is supported on parallel cantilever arms, and in the rest condition is biased against a backplate by the arms. Air under pressure lifts the test head off the backplate during position sensing, after which the air flow ceases to permit the test head to move imperceptibly against the back plate for stability during the test procedure itself.

The air bearing of the known testing device is placed along the test tool axis in a plane perpendicular to the second axis and at a distance from the first axis where it exhibits

slight asymmetry of clamping, which may result in slight movement of the tip of the test tool of the order of 0.2-0.3 μm. This very small amount may influence the recorded load and displacement.

According to yet another aspect of the invention, there is provided a bond testing device comprising a test head mounted on a base plate by a cantilever arm extending on a first axis, wherein the test head is biased at right angles to the first axis on a second axis into engagement with the base plate by the arm, and an air bearing is provided operatively between the test head and the base plate to urge the test head out of engagement with said base plate, the test head having a test tool axis at right angles to said first and second axes, wherein the air bearing is in a plane perpendicular to said second axis and which is on said first axis.

Such an arrangement eliminates asymmetry of clamping. Preferably the air bearing is on the opposite side of the test head to said arm.

According to yet another aspect of the present invention there is provided a unitary adjustment device for providing relative movement in three axes, said device comprising four rigid members connected in sequence by resilient members the resilient members permitting relative movement between the respective ends in one plane only.

Preferably the resilient members comprise leaf springs adapted to bend in one plane only. The leaf springs in the preferred embodiment each comprise two identical leaves at a distance; the distance is preferably substantially equal to or greater than the width of the spring, which in the preferred embodiment is at least twice the length. Preferably all leaf springs are of substantially the same length, width and thickness.

The adjustment device of the preferred embodiment includes adjustment screws for each of three axes, the screws being threaded in one rigid member and bearing on another rigid member, and being operative to bend a respective resilient member extending therebetween. In the preferred embodiment two of said screws are threaded in one of said members. One or more of said screws may extend from one rigid member through an aperture in a second rigid member to bear on a third rigid member.

In the preferred embodiment said device has a substantially rectangular envelope, said resilient members lying at least partially along exterior sides thereof.

The resilient members preferably have a rest condition at one side of the associated axis of extension so as to ensure that bending thereof is through said axis from one side to the other. This arrangement minimizes slight positional variations due to bending of the arms away from the principal axis.

The unitary device according to this aspect is preferably machined from solid material, typically aluminium, and provides adjustment along each axis of ± 1 mm.

Other features of the invention will be apparent from the following description of preferred embodiments shown by way of example only in the accompanying drawings in which:

Figure 1 is an isometric view of a housing.

Figure 2 is an end view of the housing in Fig.1.

Figure 3 illustrates in side elevation a test tool within a sleeve.

Figure 4 is a transverse section corresponding to Fig.3.

Figure 5 shows the assembly of Fig.4 on first insertion into a housing.

Figure 6 shows the sleeve of Fig.5 moved to the retracted condition.

Figure 7 shows the sleeve latched on the housing.

Figure 8 is a partial side elevation of an alternative housing.

Figure 9 is an elevation of a test cartridge according to the invention.

Figure 10 is a section on line A-A of Fig. 9.

Figure 11 is an elevation of an alternative test cartridge.

Figure 12 is a section on line A-A of Fig. 11.

Figure 13 is a section on line B-B of Fig. 11.

Figure 14 is an isometric view of an adjustment block.

Figure 15 is a longitudinal section through an alternative tip/shield combination.

With reference to the drawings, Figs.1 and 2 illustrate a tubular housing (11) of metal, having bayonet pins (12) (one only shown) and axially extending slots (13) defining a resilient tongue (14) in the wall of the housing.

Figs. 3 and 4 illustrates a rigid test tool (20) having a cylindrical shank (21) and a conical tip (22); a reduced diameter cylindrical mid portion (23) is provided between the shank and tip. The shank has a flat on one side for engagement with the tongue (14).

A sleeve (26) of resilient plastics material (e.g. Nylon) surrounds the tool and has a continuous tubular portion (27) at the distal end to protect the tip as illustrated in Fig.4. The proximal portion comprises four relatively flexible arms (28), two of which define bayonet recesses (29) and two of which define internal latch projections (30) (see Fig.7).

At the base of the tubular portion (27), opposite internal projections (31) engage in the mid portion (23), and permit relative axial movement limited by abutment at opposite ends of the mid-portion (see Figs. 5 and 6).

Just proximal of the projections (31), an annular recess (32) is provided to closely engage the base of the conical tip (22) by releasable snap fitting.

A test probe which is separated from the test machine has the configuration illustrated in Figs.3 and 4, the sleeve being maintained in the advanced condition by virtue of the snap fitting provided by recess (32).

To install the tool, the exposed shank is inserted into the housing where the flat is engaged by the tongue as illustrated in Fig.5. The user then pushes the sleeve firmly upwards, thus releasing the snap fit of recess (32) and exposing the probe tip (22). The bayonet pins (12) are engaged by the bayonet recesses, and on rotation to the engaged condition, internal projections (30) of the sleeve snap into corresponding recesses (33) of the housing (Fig.7). The bayonet connection is thereby latched. Means other than a bayonet latch may be used.

It will be noted that the shank (21) is maintained in abutment with the blind end of the tubular housing (11) by the sleeve.

To remove the test tool the sleeve is rotated to release the latch projections (30) (suitable ramp faces are provided) and the bayonet connection. The sleeve is then free to slide downwards on the probe until the internal abutment (31) reaches the distal travel limit. At this stage the shank (20) is retained in the housing by resilience of the tongue (14). Further downward movement of the sleeve overcomes resistance of the tongue, and the tool is released from the housing.

It will be understood that the sleeve provides a convenient means of gripping the tool without risk of damage, and ensures that the tool is automatically shielded and unshielded as required. It will further be understood that in this embodiment the gripping force of the tongue (14) should be greater than the drag of the arms (28) on the housing and the latching force of the recess (32), so as to ensure reshielding on tool removal. The tongue and flat on the shank ensure correct angular orientation of the tool, which may be necessary in the case of for example a hook.

Fig. 8 illustrates an alternative housing 11a in which the distal end 15 is tubular and provides a guide for the tool shank. The tongue 14a is thus protected from outward bending forces which might occur in the embodiment of Fig. 1 if the tool shank is not inserted axially.

Fig. 15 illustrates an alternative tip/shield combination. The housing 11a is substantially as illustrated in Fig.8, and contains a tool comprising a tubular shank 21a into which is fitted a tool tip 22a. The tip 22a is located against a shoulder, as illustrated, and retained by for example an engineering adhesive. The region of the shank 21a distal of the tip 22a could in the alternative be solid.

As previously described, the shank has a reduced diameter mid-portion 23a with annular abutment faces at either end thereof.

The shield 26a comprises a tubular member of a resilient plastics material such as Nylon, and having internal circular shoulders 34, 35 which allow reciprocation of the shield on the reduced diameter portion 23a. As illustrated the shield is in the withdrawn condition with shoulder 34 against the upper abutment face. Movement of the shield in the downward direction terminates when shoulder 35 contacts the lower abutment face, and in this position the tip of the tool is protected.

Between the shoulders 34, 35 an internal circular recess 36 houses a resilient 'O' ring 37 which bears on the surface of the mid-portion 23a with a frictional force sufficient to hold position, but to allow relative movement on application of a light pulling or pushing force. The upper end 38 of the shield has an enlarged diameter to permit grasping thereof.

In use the sleeve automatically retracts as the tool is mounted on the test machine, and advances as the tool is removed, the gripping force of the tongue 14a being greater than that exerted by the 'O' ring 37.

As an alternative to an 'O' ring, adequate friction could be achieved by, for example, an insert patch of a suitable elastomer, or an integrally moulded friction member of a plastics shield 26A, such as an internal circular nylon lip.

Figs. 9 and 10 illustrate another aspect of the present invention. A pull test cartridge 40 for attachment to a bond tester comprises a body 41 from which extends parallel arms 42,43 to a test head 44. The arms 42,43 have depth and constitute a leaf spring which allows relative up and down movement of the test head. In use the arms carry strain gauges to measure the bending force applied thereto. Fixing apertures 45,46 are provided to secure the cartridge to the bond testing machine. Extending downwardly from the test head and relatively rotatable therein is a tool housing 11a of the kind described in relation to Fig. 8.

Also fixed securely on the test machine, via apertures 47,48 is a motor mounting 49 which has parallel spring arms 51,52 terminating in a mounting plate 53 to which a vertical axis motor 54 is secured in any suitable manner. As shown, the motor drive axis is on the axis of the housing 11a.

A coupling is provided between the motor 54 and housing 11a by virtue of the jaw 57 and drive pin 58. As better illustrated in Figure 10, the cross pin and jaw engage in one orientation only, thus ensuring a fixed angular relationship. In the rest condition, the jaw 57 exerts no axial load on the housing 11a, but by virtue of its tapered mouth and parallel sided inner portion, the jaw engages the drive pin 58 without radial play.

A pneumatic actuator 55 is fixed to the test machine by a mounting 59 and has a ram 56 extendable against the plate 53 to lift the motor relative to the housing.

As will be readily appreciated, the motor can be positively de-coupled by actuation of the ram 56, thereby ensuring that the mass of the test head is significantly reduced and the potential of the pin to rub on one side of the jaw is eliminated.

A shear test cartridge 60 is illustrated in Figs. 11-13 and includes a test head 61 supported by cantilever arms 62,63. A test tool 20, of the kind illustrated in Figs. 1-7 is secured to a housing 64. A backing plate 65 lies behind the test head 61, and supports an air chamber 66 which is lightly biased into contact a pressure plate 67 by the arms 62,63.

A vertical plane, indicated in Fig. 13 by arrow 68 comprises an air bearing which, when supplied with air under pressure, lifts the pressure plate 67 off of the air chamber 66 so as to allow the test head to float without friction, in the manner described in US Patent 6,078,387.

As best seen in Fig. 13, the plane 68 of the air bearing lies on the centre line of the test head at the other side of the arms 62,63. Such an arrangement ensures minimal vertical movement of the tip of the test tool as the air bearing is released and re-applied.

Another aspect of the present invention is illustrated in Fig. 14. A tool 71 is adjustable minutely in three planes by virtue of a flexural adjustment block 72 which is attached to a mounting 73 in any suitable manner. The mounting itself may include relatively coarse means of bringing the tool close to the desired position, and may for example comprise simple releasable clamps and relatively sliding members.

The block 72 comprises a base 73 to which a first intermediate member 74 is attached by thin parallel cantilever arms 75. The arms have significant depth, as illustrated, so as to resist vertical movement of the member 74. The arms 75 are somewhat springy and allow movement of the first intermediate member in the X plane. A screw 76 is threaded in the base 73 and bears on the first intermediate member so as to move it in the X plane against the resilient force exerted by the arms 75; as shown, in the rest condition the arms 75 are set back from the Y plane so as to give some travel on either side thereof.

A second intermediate member 77 is born by similar parallel arms 78 which extend from the first member 74. The arms 78 also are to one side of the adjustment plane, and an adjustment screw 79 is threaded in the base 73.

A terminal member 81 is attached to the second member 77 by parallel arms 82, again to one side of the adjustment plane, and acted upon by an adjustment screw 83 threaded in the first member 74 and passing through an aperture in the second member 77. The tool 71 is mounted on a shaft 84 of the terminal member 81.

It will be appreciated that the block 72 comprise, apart from the screws 76,79,83, a unitary member in which the inherent resilience of the arms permits a small degree of adjustment of the tool in all three axes. The intermediate and terminal members 74,77,81 are comparatively stiff in relation to the arms so that all movement of the tool is effected by the adjustment screws, which are conveniently placed at the exterior for easy manipulation.

The adjustment block according to this aspect can be used for any kind of tool where micro adjustment of position without backlash is required, for example in positioning a test tool to apply a shear load to a soldered connection.

Claims

1. A test device for mechanical testing of electrical bonds, the device having a body adapted to be secured in a holder, an elongate tubular housing extending from the body, and a test tool located in said housing and projecting therefrom, wherein a tubular sleeve is provided around said tool, and is slidable axially thereof from an extended position in which the tip of the test tool is shielded, to a withdrawn position in which the tip of the test tool is exposed, the sleeve further including gripping means to maintain the sleeve in the extended position.

2. A device according to claim 1 wherein said gripping means comprise a friction device acting between said tool and sleeve transverse to the direction of relative movement thereof.

3. A device according to claim 2 wherein said friction device is a resilient elastomer.

4. A device according to claim 3 wherein said gripping means comprise a resilient 'O' ring fixed relative to one of the tip and shield and slidable on the other of the tip and shield against the inherent gripping force.

5. A device according to claim 4 wherein the 'O' ring is housed in an internal annular recess of the shield.

6. A device according to claim 3 wherein said sleeve is of a resilient plastics, and said gripping means is integrally moulded therewith.

7. A device according to claim 6 wherein said gripping means comprises a circular internal projection of said sleeve.

8. A device according to any preceding claim wherein said shield further includes a releasable locking means to maintain the shield in the extended position relative to said tool.

9. A device according to any preceding claim wherein said sleeve provides grasping means whereby the test tool is inserted and removed from the housing.

10. A device according to claim 9 wherein the sleeve further constitutes releasable retention means for said tool.

11. A device according to any preceding claim wherein said sleeve and test tool have stroke limiting means to determine relative axial end positions.

12. A device according to claim 11 wherein the sleeve has a distal end comprising a cylinder and a proximal end comprising a plurality of circumferentially spaced and inwardly directed spring arms having latch projections thereon for engagement in one or more corresponding latch recesses of the housing.

13. A device according to claim 12 wherein the sleeve further includes a bayonet connection with the housing whereby the sleeve is maintained in a desired annular position, the latch projections engaging the latch recesses only on full engagement of the bayonet.

14. A device according to any preceding claim wherein said housing includes an internal abutment for the test tool whereby, in the latched condition, the tool and abutment are in direct contact.

15. A device according to any preceding claim wherein the test tool further includes means to prevent relative rotation thereof relating to the housing.

16. A device according to claim 15 wherein said tool further comprises a flat of the tool shank engageable with a corresponding internal surface of the housing.

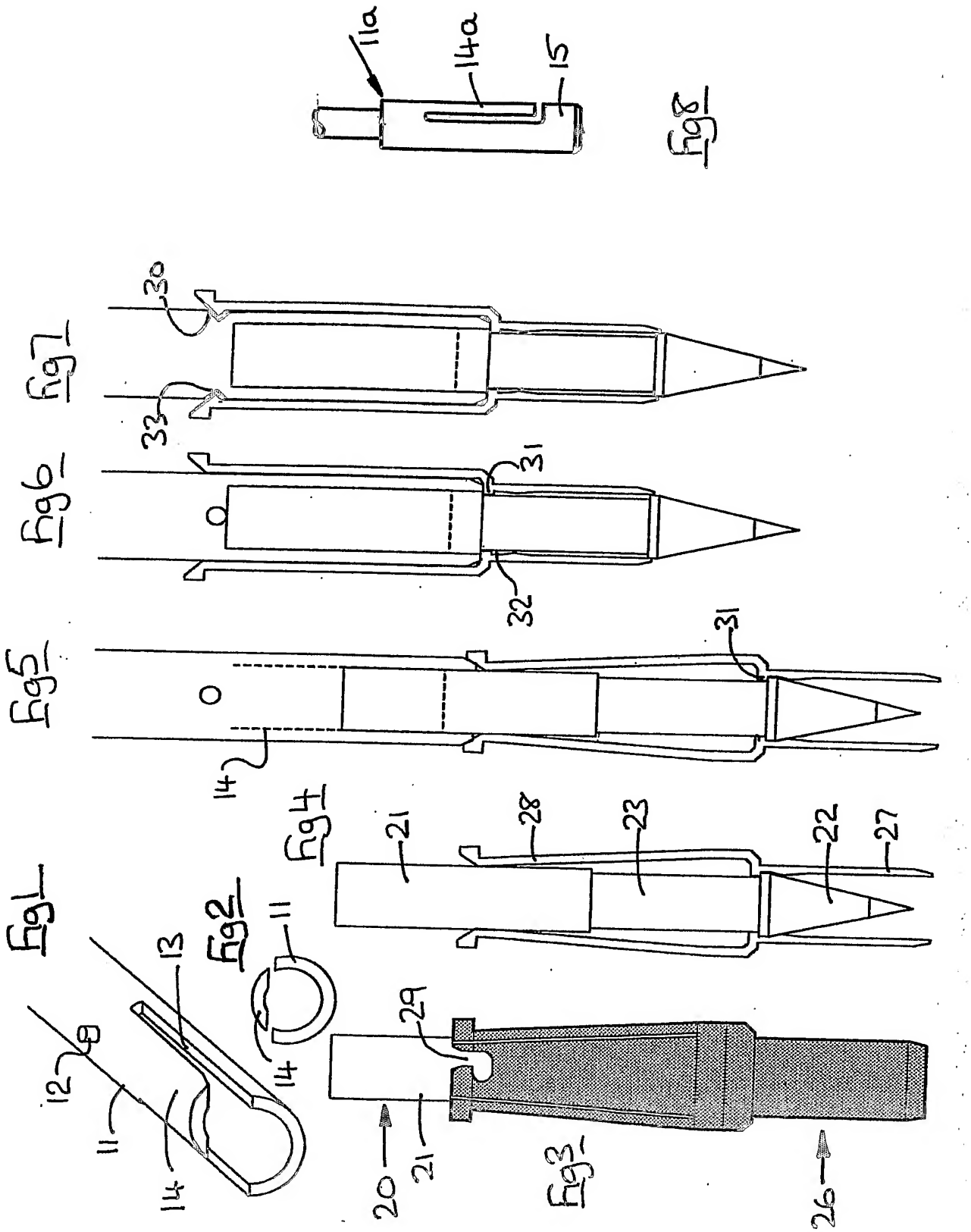
11a
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Fig8
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Fig3
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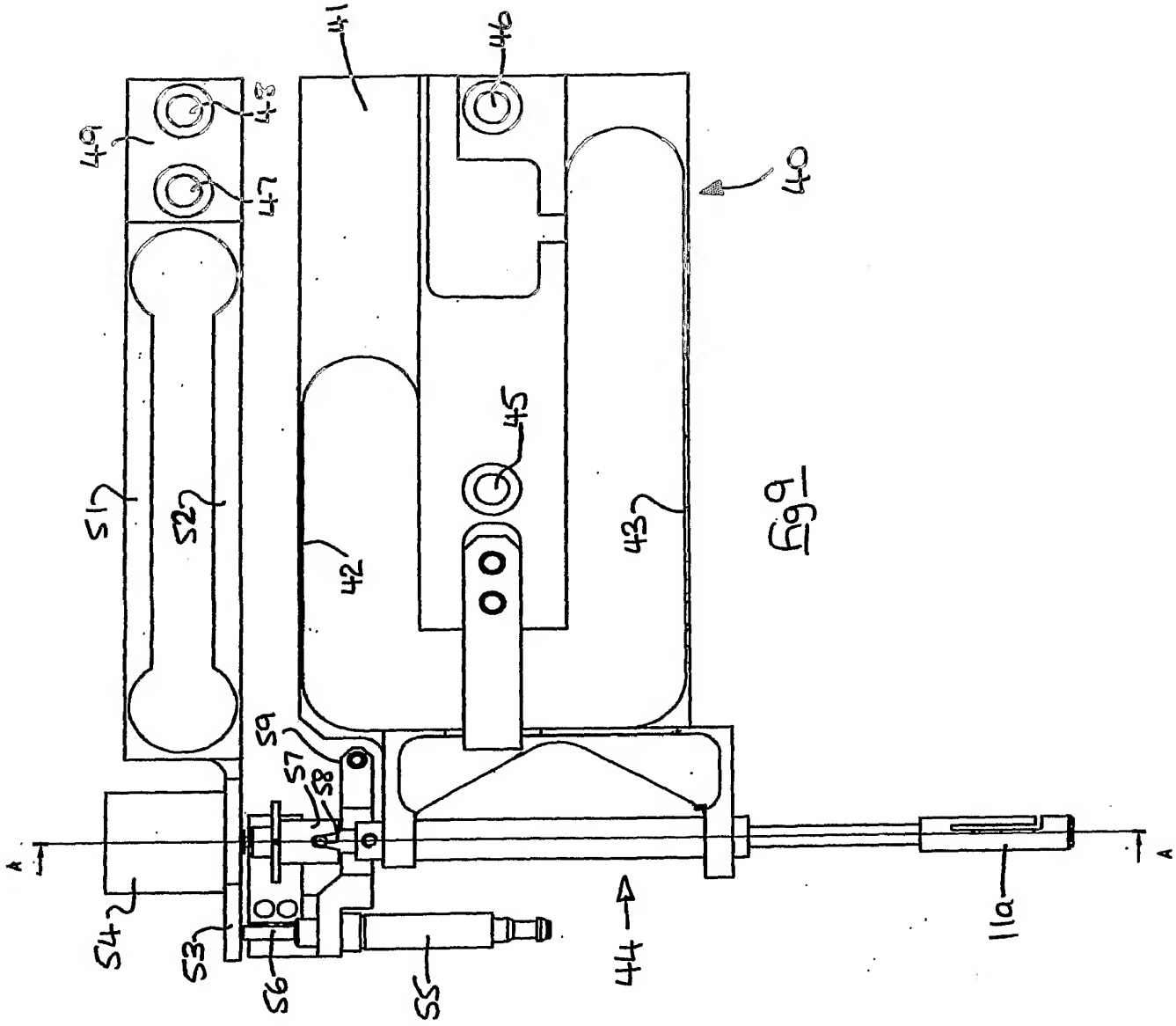
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Fig 9

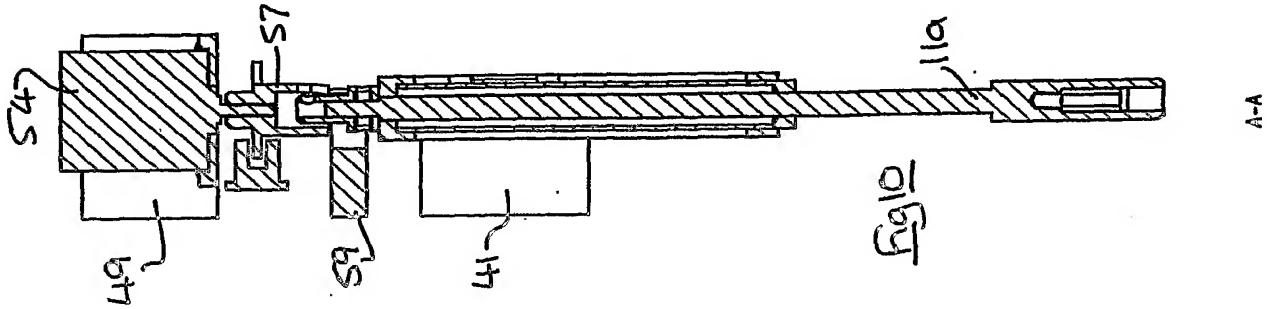
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Fig 10

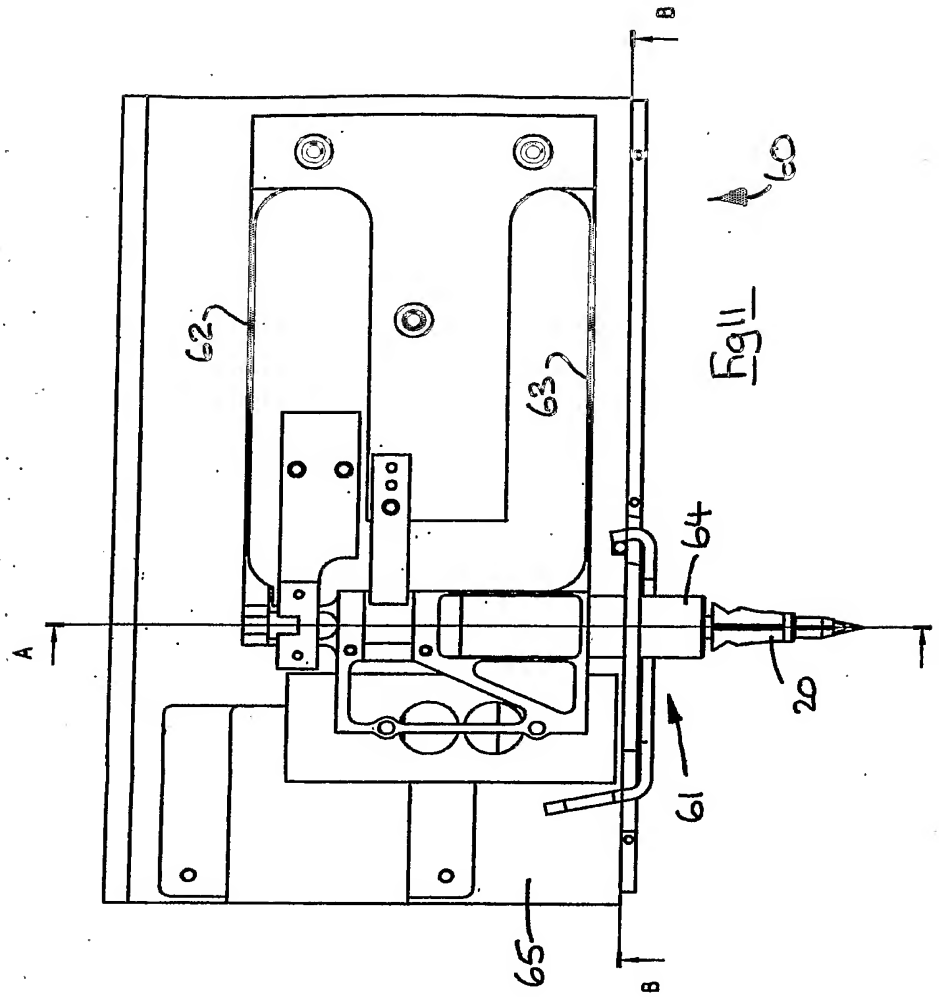

Fig11

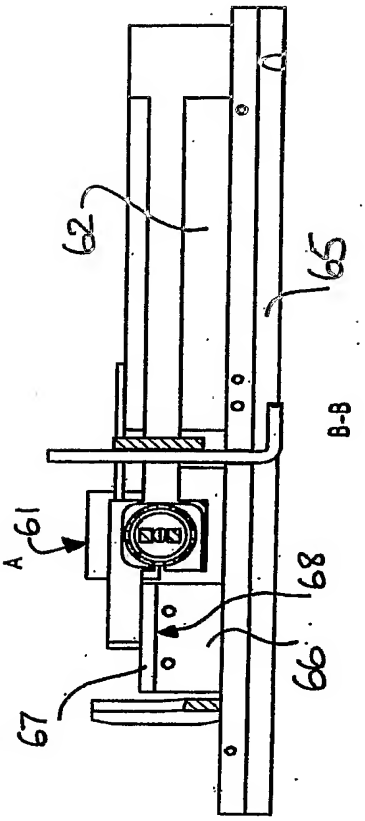

Fig13

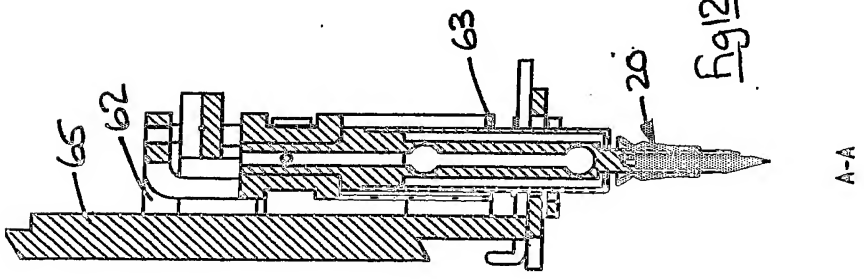

Fig12

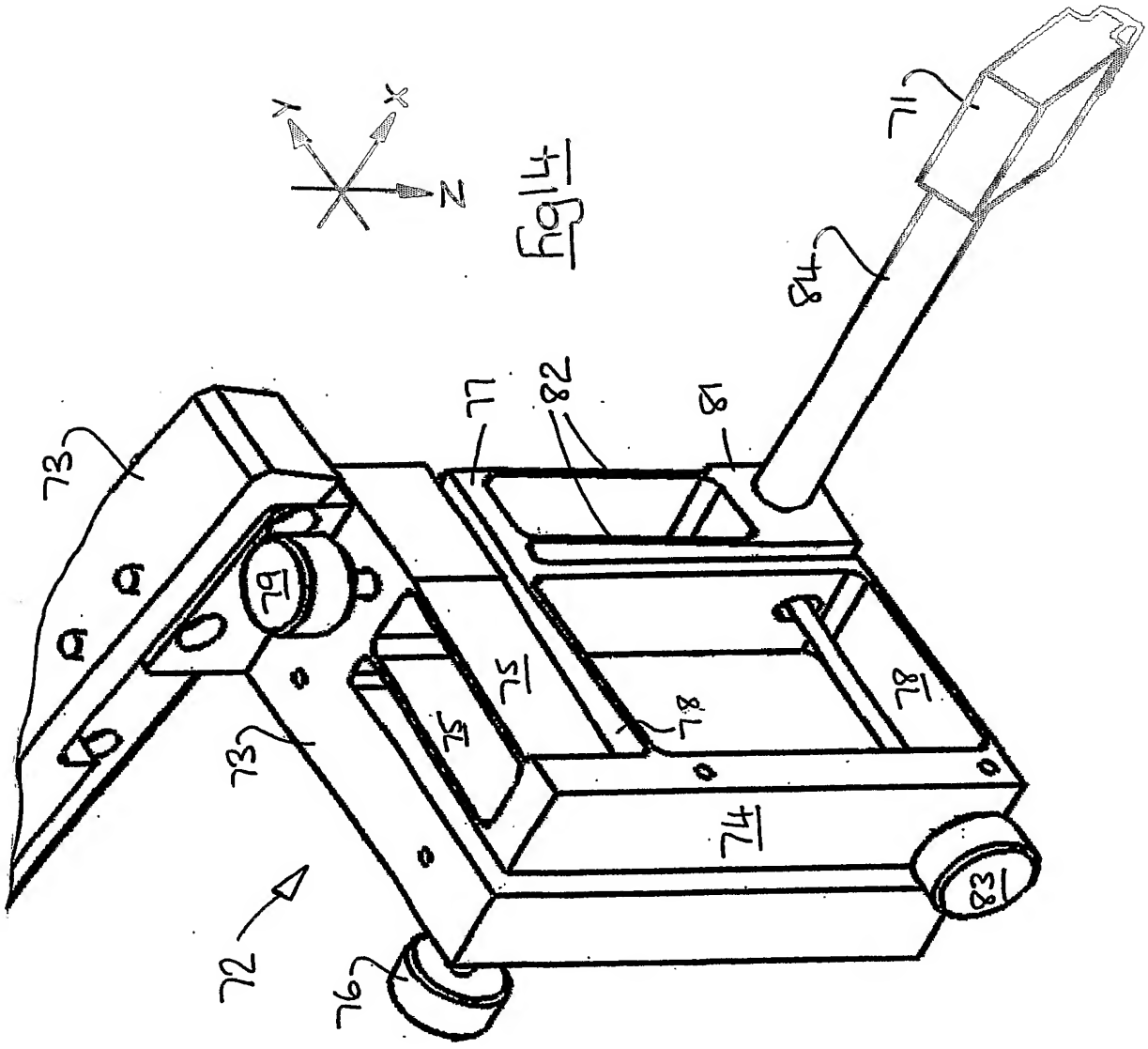

Fig 14

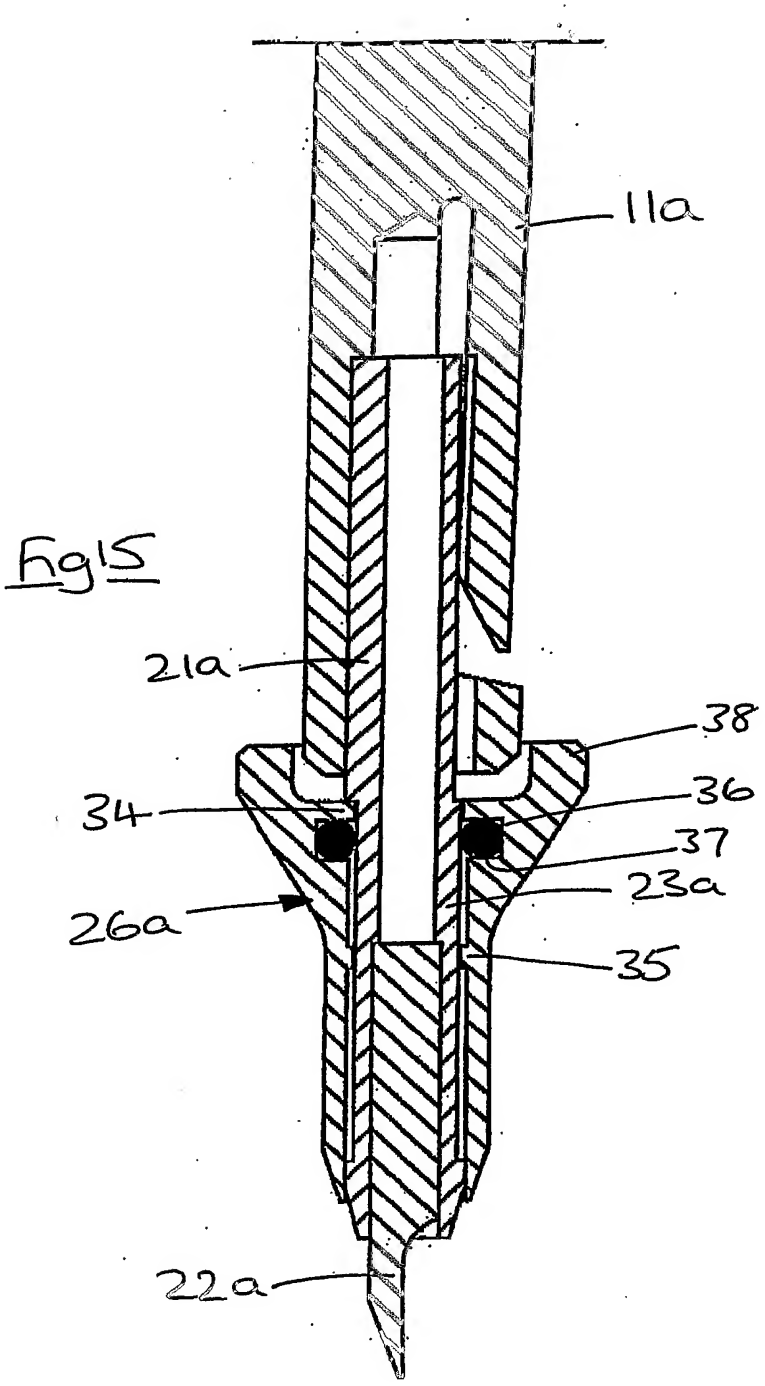

Fig 15

INTERNATIONAL SEARCH REPORT

Ir :ional Application No
PCT/GB2004/001142

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01N19/04 G01R31/04 G01R31/316

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, BIOSIS, COMPENDEX, EMBASE, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 078 387 A (SYKES ROBERT) 20 June 2000 (2000-06-20) cited in the application the whole document	1-16
A	EP 0 772 036 A (STAUDINGER GEROLD) 7 May 1997 (1997-05-07) the whole document	1-16
A	US 2001/010322 A1 (IKOMA KAZUYA) 2 August 2001 (2001-08-02) the whole document	1-16

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 May 2004	08/06/2004

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